# Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead

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# C.2.3 CENTRAL CALIFORNIA COAST COHO SALMON

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## C.2.3.1 Previous BRT Conclusions

The Central California Coast (CCC) coho salmon Evolutionarily Significant Unit extends from Punta Gorda in Northern California south to and including the San Lorenzo River in Central California (Weitkamp et al. 1995). The status of coho salmon throughout their West Coast range, including the CCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates with information pertaining to the CCC ESU were published by NMFS in 1996 (NMFS 1996a, b). Analyses from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

### Status indicators and major risk factors

Data on abundance and population trends of coho salmon within the CCC ESU were limited. Historical time series of spawner abundance for individual river systems were unavailable. Brown et al. (1994) presented several historical point estimates of coho salmon spawner abundance (excluding ocean catch) for the entire state of California for 1940 and for various rivers and regions in the early 1960s and mid 1980s (Table C.2.3.1). Coho salmon were estimated to number between 200,000 and 500,000 statewide in the 1940s (E. Gerstung, CDFG, pers. comm., cited in Brown et al. 1994). Coho salmon spawning escapement was estimated to have declined to about 99,400 fish by the mid-1960s, with approximately 56,100 (56%) originating from streams within the CCC ESU (Table C.2.3.1). In the mid-1980s, spawning escapement was estimated to have dropped to approximately 30,480 in California and 18,050 (59%) within the CCC ESU. Employing the "20-fish rule" (see status review update for Southern OR-Northern CA Coast coho salmon for details), Brown et al. (1994) estimated wild and naturalized coho salmon populations at 6,160 (47% of the statewide total) for the CCC ESU during the late 1980s (Table C.2.3.1). All of these estimates are considered to be "best guesses" based on a combination of limited catch statistics, hatchery records, and personal observations of local biologists (Brown et al. 1994).

Further information regarding status was obtained from Brown et al.'s (1994) analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support populations. Of 133 historical coho salmon streams in the CCC ESU for which recent data were available, 62 (47%) were determined to still support coho runs while 71 (53%) apparently no longer support coho salmon (Table C.2.3.2). A subsequent analysis of surveys from 1995-1996 found a somewhat higher (57%) percentage of occupied streams (NMFS 1996b, based on pers. comm. with P. Adams, NMFS Southwest Fisheries Science Center).

Nehlsen et al. (1991) provided no specific information on individual coho salmon populations in their 1991 status review, but concluded that salmon stocks in small coastal streams north of San Francisco were at moderate risk of extinction and those in coastal streams south of San Francisco Bay were at high risk of extinction. A subsequent status review by the

Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992) found four populations (Pudding Creek, Garcia River, Gualala River, and Russian River) to be at high risk of extinction and five (Ten Mile, Noyo, Big, Navarro, and Albion rivers) as stocks of concern.

Table C.2.3.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Central California Coast Evolutionarily Significant Unit.

| | Estimated Escapement | | |
|---|---|---|---|
| | **CDFG (1965)[a]** | **Wahle & Pearson (1987)[b]** | **Brown et al. (1994)[c]** |
| **River/Region** | **1963** | **1984-1985** | **1987-1991** |
| Ten Mile River | 6,000 | 2,000 | 160[d] |
| Noyo River | 6,000 | 2,000 | 3,740 |
| Big River | 6,000 | 2,000 | 280 |
| Navarro River | 7,000 | 2,000 | 300 |
| Garcia River | 2,000 | 500 | |
| Other Mendocino County | 10,000 | 7,000[e] | 470[f] |
| Gualala River | 4,000 | 1,000 | 200 |
| Russian River | 5,000 | 1,000 | 255 |
| Other Sonoma County | 1,000 | | 180 |
| Marin County | 5,000 | | 435 |
| San Mateo & Santa Cruz Counties | 4,100 | 550 | 140 |
| San Mateo County | 1,000 | | |
| Santa Cruz County (excl. San | 1,500 | 50 | |
| San Lorenzo River | 1,600 | 500 | |
| ESU Total | 56,100 | 18,050 | 6,160 |
| California Statewide Total[e] | 99,400 | 30,480 | 13,240 |

[a] Values excludes ocean catch.
[b] Estimates are for wild or naturalized fish; hatchery returns excluded.
[c] Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
[d] Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.
[e] Value may include Marin and Sonoma County fish.
[f] Appears to include Garcia River fish.
[g] Estimated number of coho salmon for CCC ESU and California portion of the SONCC ESU combined.

Risk factors identified by the BRT included extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the BRT concluded that the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and that there were relatively few native coho salmon left in the ESU (Weitkamp et al. 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (NMFS 1996a), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (Kingfisher Flat) and Noyo River broodstocks have regularly incorporated

wild broodstock and, thus, were unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions were identified as natural factors contributing to reduced run size.

Table C.2.3.2. Historical presence of coho salmon in the CCC ESU, as determined by Brown et al. (1994) and the California Department of Fish and Game's analysis of recent presence (1995-2001). County classifications are based on the location of the mouth of the river system. Data from CDFG (2002). Note that methods for estimating occupancy rates differed between Brown et al. (1994) and CDFG (2002); thus, direct comparisons across time periods are inappropriate.

| | Brown et al. (1994) Calendar years 1987-1990 | | | | CDFG (2002) Years 1995-2001 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **County/River Basin** | **no. of streams** | **no. of streams w/info.** | **coho present** | **%** | **no. of streams surveyed in 2001** | **no. of streams w/coho present** | **no. of streams w/coho assumed present** | **no. of streams w/coho not detected in 2001** | **Percent present (1995-2001)** |
| **Mendocino Co.** | | | | | | | | | |
| Coastal | 44 | 35 | 13 | 37% | 30 | 11 | 10 | 19 | 52% |
| Ten Mile River | 11 | 10 | 7 | 79% | 11 | 9 | 0 | 2 | 82% |
| Noyo River | 13 | 12 | 11 | 92% | 8 | 7 | 5 | 1 | 92% |
| Big River | 16 | 13 | 11 | 85% | 8 | 3 | 6 | 5 | 64% |
| Navarro River | 19 | 8 | 4 | 50% | 14 | 6 | 1 | 8 | 47% |
| Subtotal | 103 | 78 | 46 | 59% | 71 | 36 | 22 | 35 | 62% |
| **Sonoma County** | | | | | | | | | |
| Coastal | 10 | 2 | 1 | 50% | 4 | 0 | 0 | 4 | 0% |
| Gualala River | 11 | 2 | 1 | 50% | 10 | 0 | 0 | 10 | 0% |
| Russian River | 32 | 24 | 2 | 8% | 29 | 1 | 1 | 28 | 0% |
| Subtotal | 53 | 28 | 4 | 14% | 43 | 1 | 1 | 42 | 4% |
| **Marin County** | | | | | | | | | |
| Coastal[a] | 10 | 7 | 7 | 100% | 15 | 6 | 0 | 9 | 40% |
| Subtotal | 10 | 7 | 7 | 100% | 15 | 6 | 0 | 9 | 40% |
| **Tribs. to S.F. Bay** | | | | | | | | | |
| Coastal | 7 | 7 | 0 | 0% | 0 | 0 | 0 | 0 | 0% |
| Subtotal | 7 | 7 | 0 | 0% | 0 | 0 | 0 | 0 | 0% |
| **South of S.F. Bay** | | | | | | | | | |
| Coastal | 13 | 13 | 5 | 38% | | | | | |
| Subtotal | 13 | 13 | 5 | 38% | | | | | |
| ESU Total | 186 | 133 | 62 | 47% | 135 | 43 | 23 | 92 | 42% |

[a] CDFG (2002) included five tributaries of Salmon Creek, a Sonoma County stream that empties into Tomales Bay, in their totals for Marin County.

### Previous BRT conclusions

Based on the data presented above, the BRT concluded that all coho salmon stocks in the CCC ESU were depressed relative to historical abundance and that most extant populations have been heavily influenced by hatchery operations. They unanimously concluded that natural populations of coho salmon in this ESU were in danger of extinction (Weitkamp et al. 1995). After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction, while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (NMFS 1996b).

### Listing status

Coho salmon in the CCC ESU were listed as threatened in October 1996.

## C.2.3.2 New Data and Updated Analyses

Significant new information on recent abundance and distribution of coho salmon within CCC ESU has become available, much of which has been summarized in two recent status reviews (NMFS 2001b; CDFG 2002). Most of these data are of two types: 1) compilations of presence-absence information for coho salmon throughout the CCC during the period 1987 to the present, and 2) new data on densities of juvenile coho salmon collected at a number of index reaches surveyed by private timber companies, CDFG, and other researchers. Excepting adult counts made at the Noyo Egg Collecting Station, which are both incomplete counts and strongly influenced by hatchery returns, there are no current time series of adult abundance within this ESU that span 8 or more years. Outmigrating smolts have been trapped at two trapping facilities in Caspar Creek and Little River since the mid-1980s; however, these are partial counts and only recently have mark-recapture studies been performed that allow correction for capture efficiency at these two sites. Thus, these smolt counts can only be considered indices of abundance.

Two analyses of presence-absence data have recently been published. CDFG (2002) performed an analysis that focused on recent (1995-2001) presence of coho salmon in streams identified as historical producers of coho salmon by Brown and Moyle (1991). NMFS (2001b) published an updated status review that analyzed coho salmon presence in streams throughout the CCC during the period 1989 to 2000. Scientists at NMFS' Southwest Fisheries Science Center have continued to compile information of coho salmon presence-absence and have incorporated data into a database that is now summarized by broodyear (rather than year of sampling) and covers broodyears 1986-2001. Data from CDFG's 2001 field survey of the Brown and Moyle (1991) streams has been incorporated into this database. Analyses presented in the present status review update supercede those presented in NMFS (2001b).

### CDFG presence-absence analysis

**Methods—**Methods used by CDFG (2002) for analyzing presence-absence information in the CCC differed from those used for the SONCC analysis. Analysis focused on results from

CDFG's 2001 summer juvenile sampling effort in which 135 of 173 streams identified by Brown and Moyle (1991) as historical coho salmon streams within the CCC ESU were sampled. Additionally, CDFG assumed presence of coho salmon in any stream for which presence had been detected during any 3 consecutive years during the period 1995-2001. An estimate of percent coho salmon presence was calculated by totaling the number of streams for which presence was either observed or assumed, and dividing by the total number of streams surveyed, inclusive of those where presence was assumed. No formal statistical analysis of trends was performed because of the lack of comparable data from previous time periods.

**Results—**For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42% of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62%), followed by Marin County (40%), Sonoma County (4%), and San Francisco Bay tributaries (0%) (Table C.2.3.2). Because of differences in the specific streams considered and methods for estimating occupancy rates, these numbers are not directly comparable with those derived by Brown et al. (1994). Nevertheless, the regional and overall ESU patterns are generally concordant for the two studies, indicating substantial variation in occupancy rates across the ESU with lower occupancy rates in the southern portion of the ESU (Table C.2.3.2).

## NMFS presence-absence analysis

**Methods—**Scientists at NMFS' Southwest Fisheries Science Center compiled survey information from streams with historical or recent evidence of coho salmon presence within the CCC ESU. Data were provided primarily by the California Department of Fish and Game, private landowners, consultants, academic researchers, and others who have conducted sampling within the CCC during the years 1988 to 2002. The majority of data come from summer juvenile surveys, though information from downstream migrant trapping and adult spawner surveys were also included. Observations of presence or absence for a particular stream were assigned to the appropriate broodyear based on the life stages observed (or expected in the case of absences). The resulting dataset spans broodyears 1987 to 2001, though data from the 2002 summer field season (broodyear 2001) were not fully reported at the time the analysis was performed.

Results for NMFS' presence-absence analysis are presented by major watersheds or aggregations of adjacent watersheds. Results from larger watersheds are typically presented independently, whereas data from contiguous smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams.

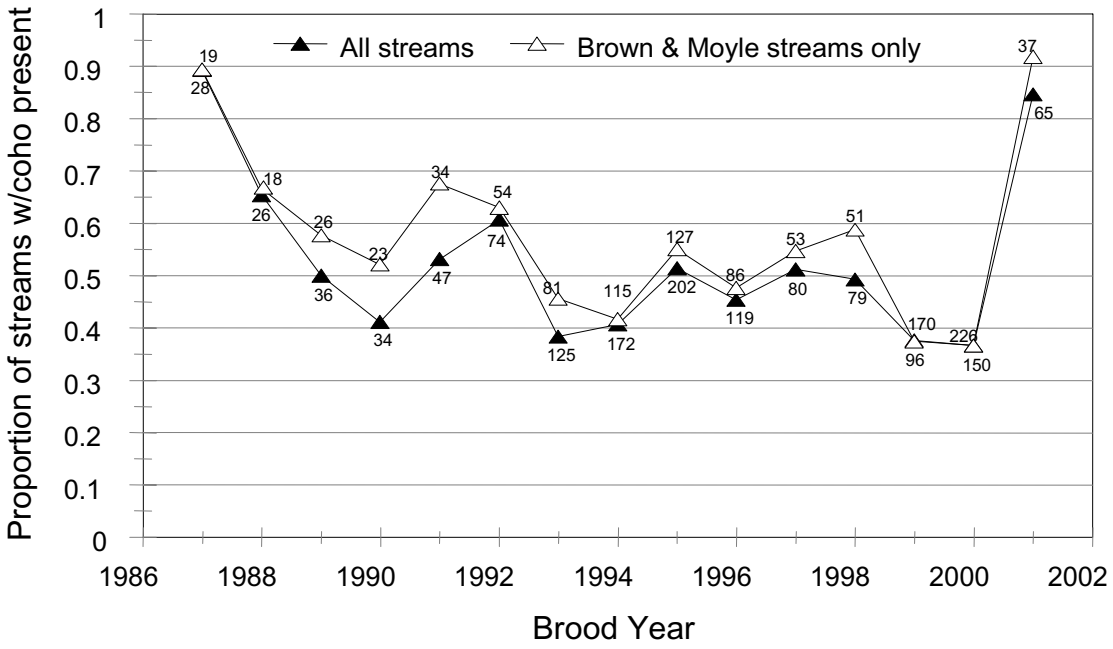


Figure C.2.3.1. Percent of streams surveyed for which coho salmon presence was detected, by broodyear, for all historical coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the CCC ESU. Sample sizes (i.e. number of streams surveyed) are shown above next to data points. Data are from combined NMFS and CDFG datasets.

**Results—**The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001 (Figure C.2.3.1). Several caveats, however, warrant discussion. First, the number of streams surveyed per year also shows a general increase from 1987 to 2000; thus, there may be a confounding influence of sampling size if sites surveyed in the first half of the time period are skewed disproportionately toward observations in streams where presence was more likely. Second, sample size from broodyear 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for broodyear 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high percentage of streams where presence was detected shown in Figure C.2.3.1 is likely inflated.

Two other patterns were noteworthy. First, compared with percent presence values for the SONCC ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general, percent occupancy was relatively low in broodyears 1990, 1993, 1996, and 1999, suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in broodyears 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2%-15%) for the Brown and Moyle streams compared with the ESU as a whole. We speculate that this pattern may reflect the fact that increased concern over CCC coho salmon in the mid-1990s prompted increased sampling of

streams in the CCC, including streams other than those traditionally known to support coho salmon. Lower occupancy rates at these sites might be expected if they represent habitats that are generally less suitable for coho salmon.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 72% in 1987-1989, to 62% in 1990-1992, to less than 55% in the last three brood cycles (Table C.2.3.3). Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 broodyear. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late 1980s to the mid-1990s and remains below 50% for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos creeks, have lost one or more brood lineages (Smith 2001).

Results from our presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC the proportion of streams occupied is highest in Mendocino County, but that populations in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. NMFS analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any trends.

### Adult time series

No time series of adult abundance free of hatchery influence and spanning 8 or more years are available for the CCC ESU. Adult counts from the Noyo Egg Collecting Station (ECS) dating back to 1962 represent a mixture of naturally produced and hatchery fish, and counts are incomplete most years because trap operation was sporadic during the season and typically ceased after broodstock needs were met. Thus, at best they represent an index of abundance. Assuming that these counts reflect general population trends, there appears to have been a significant decline in abundance of coho salmon in the South Fork Noyo River beginning in 1977 (Figure C.2.3.2). No formal analysis of trends was conducted because of the uncertainty of the relationship between catch statistics and population size, as well as the relative contribution of hatchery fish to total numbers during the entire period of record.

### Smolt time series

California Department of Fish and Game personnel have trapped outmigrating smolts at Caspar Creek and Little River since 1986. These counts are partial counts, uncorrected for capture efficiency. As such, they provide only indices of abundance. However, they likely capture gross changes in smolt abundance over the years (Figure C.2.3.3). For Caspar Creek, the highest smolt counts occurred in the late 1980s and early 1990s, decreased in the mid-1990s, and then increased in the past three years to levels approaching those of the late 1980s (Figure C.2.2.3). For Little River, a similar pattern was observed from the late-1980s to the mid-1990s;

Table C.2.3.3. Percent of surveyed streams within the CCC ESU for which coho salmon were detected for four time intervals: broodyears 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists (based on combined NMFS and CDFG data).

| | | 1987-1989 | | | 1990-1992 | | | 1993-1995 | | | 1996-1998 | | | 1999-2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **County and River Basins** | **Number of Streams with Historical Presence** | **Number Surveyed[a]** | **Coho Present[b]** | **Coho Absent[c]** | **Number Surveyed[a]** | **Coho Present[b]** | **Coho Absent[c]** | **Number Surveyed[a]** | **Coho Present[b]** | **Coho Absent[c]** | **Number Surveyed[a]** | **Coho Present[b]** | **Coho Absent[c]** | **Number Surveyed[a]** | **Coho Present[b]** | **Coho Absent[c]** |
| **Mendocino** | | | | | | | | | | | | | | | | |
| Coastal (Punta Gorda to Abolabodiah Cr.) | 24 | 4 | 75% | 25% | 6 | 50% | 50% | 16 | 50% | 50% | 11 | 18% | 82% | 19 | 32% | 68% |
| Ten Mile River | 25 | 6 | 50% | 50% | 15 | 53% | 47% | 17 | 65% | 35% | 14 | 57% | 43% | 16 | 94% | 6% |
| Pudding Cr. to Noyo River | 43 | 4 | 75% | 25% | 8 | 88% | 12% | 35 | 66% | 34% | 15 | 80% | 20% | 38 | 68% | 32% |
| Coastal (Hare Cr. to Russian Gulch) | 14 | 8 | 100% | 0% | 4 | 100% | 0% | 9 | 67% | 33% | 9 | 67% | 33% | 4 | 75% | 25% |
| Big and Little Rivers | 28 | 5 | 20% | 80% | 7 | 57% | 43% | 20 | 75% | 25% | 16 | 81% | 19% | 16 | 38% | 62% |
| Albion River | 16 | 3 | 100% | 0% | 3 | 100% | 0% | 15 | 80% | 20% | 1 | 100% | 0% | 14 | 86% | 14% |
| Little Salmon & Big Salmon Cr. | 6 | 0 | - | - | 3 | 100% | 0% | 4 | 75% | 25% | 4 | 75% | 25% | 4 | 100% | 0% |
| Navarro River | 30 | 1 | 100% | 0% | 1 | 0% | 100% | 24 | 58% | 42% | 6 | 67% | 33% | 23 | 52% | 48% |
| Coastal (Greenwood Cr. to Brush Cr.) | 8 | 3 | 0% | 100% | 2 | 50% | 50% | 8 | 13% | 87% | 0 | - | - | 8 | 0% | 100% |
| Garcia River to Digger Cr. | 8 | 3 | 100% | 0% | 2 | 0% | 100% | 8 | 13% | 87% | 5 | 20% | 80% | 7 | 0% | 100% |
| | | | | | | | | | | | | | | | | |
| **Sonoma** | | | | | | | | | | | | | | | | |
| Gualala River | 15 | 1 | 100% | 0% | 1 | 0% | 100% | 11 | 0% | 100% | 1 | 0% | 100% | 11 | 9% | 91% |
| Fort Ross to Russian River | 55 | 5 | 40% | 60% | 14 | 50% | 50% | 37 | 54% | 46% | 29 | 24% | 76% | 37 | 11% | 89% |
| | | | | | | | | | | | | | | | | |
| **Marin** | | | | | | | | | | | | | | | | |
| Tomales Bay Rivers | 25 | 3 | 100% | 0% | 4 | 100% | 0% | 14 | 36% | 64% | 10 | 90% | 10% | 21 | 57% | 43% |
| Coastal (Redwood Cr. to Bolinas Lagoon) | 6 | 0 | - | - | 1 | 100% | 0% | 2 | 50% | 50% | 4 | 75% | 25% | 5 | 100% | 0% |
| | | | | | | | | | | | | | | | | |
| **San Francisco Bay** | | | | | | | | | | | | | | | | |
| SF Bay Rivers | 6 | 0 | - | - | 4 | 0% | 100% | 6 | 0% | 100% | 4 | 0% | 100% | 0 | - | - |
| | | | | | | | | | | | | | | | | |
| **San Mateo/Santa Cruz** | | | | | | | | | | | | | | | | |
| Coastal (SF Bay to Aptos Creek) | 17 | 7 | 100% | 0% | 7 | 100% | 0% | 13 | 69% | 31% | 14 | 57% | 43% | 12 | 67% | 33% |
| | | | | | | | | | | | | | | | | |
| **Monterey** | | | | | | | | | | | | | | | | |
| Coastal (Carmel R. to Big Sur R.) | 2 | 0 | - | - | 0 | - | - | 2 | 0% | 100% | 0 | - | - | 2 | 0% | 100% |
| **ESU Total** | **328** | **53** | **72%** | **28%** | **82** | **63%** | **37%** | **241** | **54%** | **46%** | **143** | **54%** | **46%** | **237** | **48%** | **52%** |

[a] Total number of steams surveyed at least once within the three-year interval

[b] Percentage of surveyed streams where coho were present in one or more years during the interval

[c] Percentage of surveyed streams where coho were absent in all years of survey during the interval

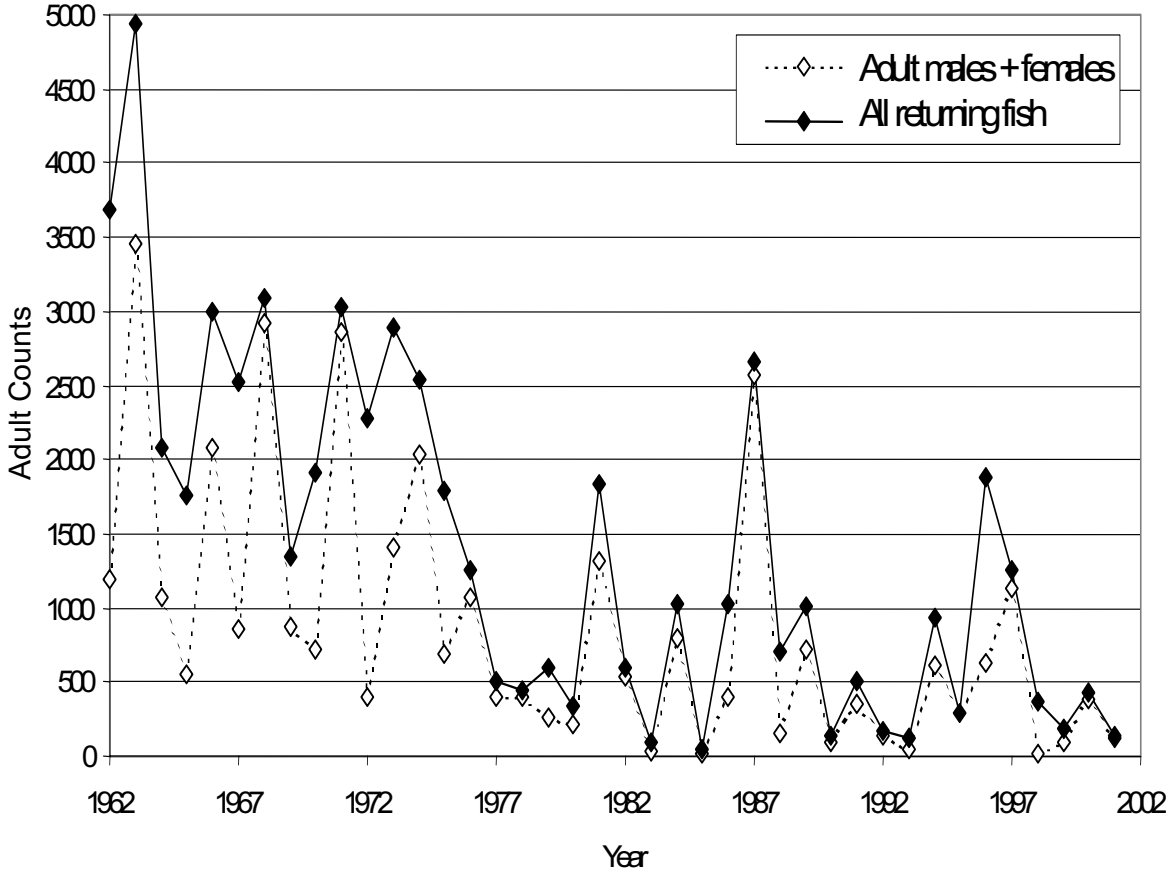


Figure C.2.3.2. Counts of adult coho salmon at Noyo Egg Collecting Station from 1962 to 2002. Solid line with closed symbol indicates total fish captured (including grilse); dashed line with open symbols indicates adult males and females only. Counts are partial counts and thus are only a crude index of adult abundance. Data source: Grass 2002.

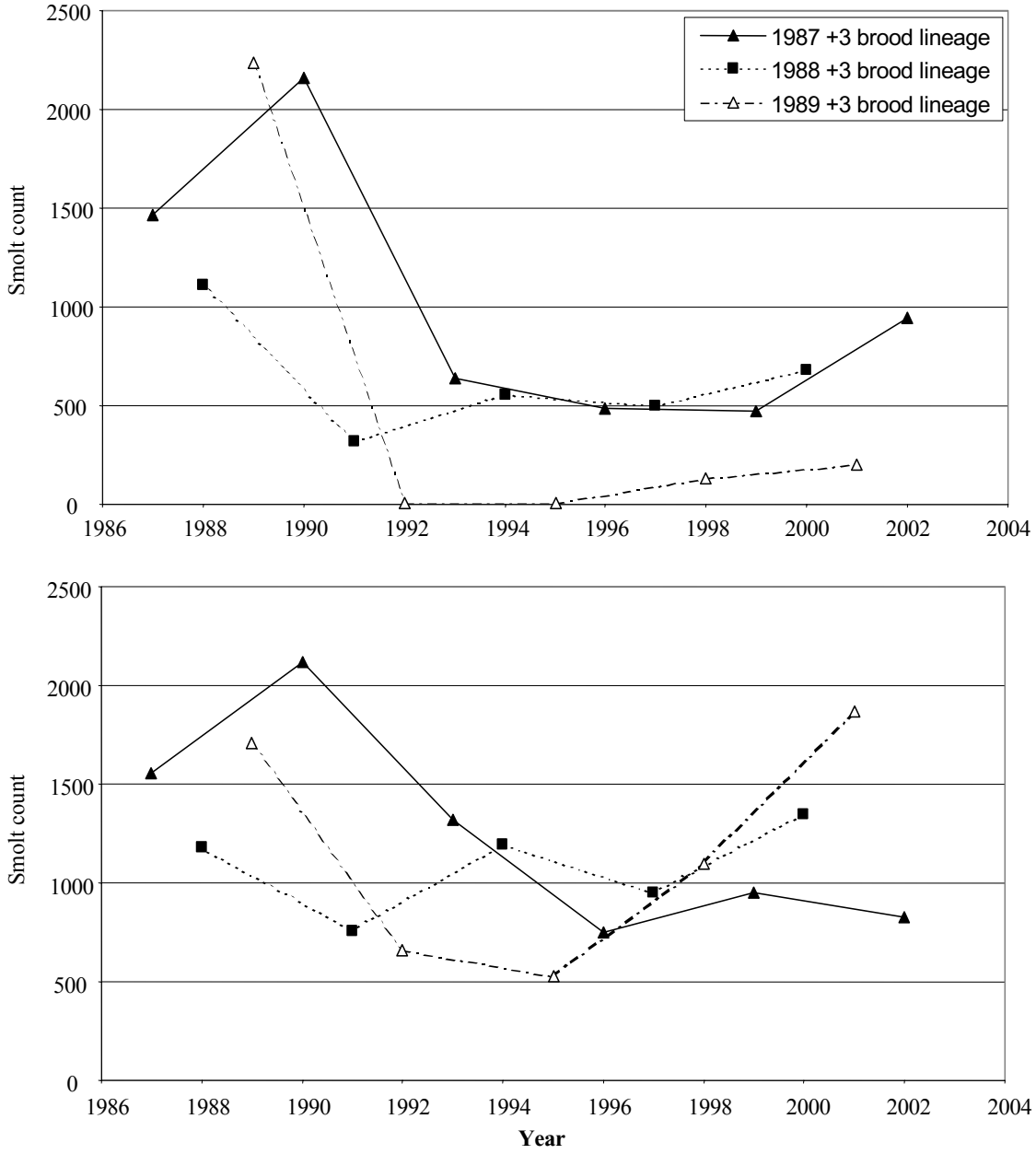


Figure C.2.3.3. Coho salmon smolt counts at a) Little River and b) Caspar Creek, Mendocino County. Lines track brood lineages. Data are counts of smolts uncorrected for trap efficiency and thus should be viewed as coarse indices of abundance. Data source: Scott Harris, CDFG, unpublished data.

Table C.2.3.4. Population trend analysis for Caspar Creek and Little River smolt outmigrant data. Trends are based on smolt counts uncorrected for trap efficiency (see text). Data source: Scott Harris, CDFG, unpublished data.

| | Geometric Means[a] | | | | |
|---|---|---|---|---|---|
| **Stream** | **Recent 3-year mean** | **3-year min.** | **3-year max.** | **Lambda[b]** | **Long-term trend[b]** |
| Caspar Cr. | 1,278 (829-1,871) | 723 (530-953) | 1,383 (1,182-2,121) | 1.002 (0.851, 1.178) | -0.017 (-0.081, 0.048) |
| Little R. | 504 (198-946) | 94 (4-640) | 1,750 (1,111-2,161) | 0.919 (0.669, 1.347) | -0.063 (-0.358, 0.232) |

[a] Values parentheses for geometric means are the range of values observed over the three-year period.

[b] Values in parentheses for lambda and trends are lower and upper bounds for 95% confidence limits.

however, only a slight increase in numbers has been observed in the last three years of records. Smolt counts were higher in each year from 1986 to 1989 than in any year since (Figure C.2.2.3). When individual brood lineages are tracked, Little River shows a decline in all three brood lineages over the period of record. In contrast, Caspar Creek shows a decline in the 1987 brood lineage, relatively consistent numbers in the 1988 brood lineage, and a decrease in the early to mid-1990s followed by an increase over the last two brood cycles to levels comparable to those observed in 1989 (Figure C.2.2.3). For both locations, the estimated long-term trend is negative but not significantly different from 0 (Table C.2.3.4). Likewise, lambda values are not significantly different from 1.

## Juvenile time series

**Methods—**While recent estimates of adult and smolt abundance are scarce for the CCC ESU, estimates (or indices) of juvenile density during summer have been made at more than 50 index sites within the CCC in the past 8 to 18 years. Methods for analyzing these data are described in detail in the SONCC coho salmon status review update. Briefly, data from individual sampling sites were ln-transformed and normalized to prevent spurious trends arising from different data collection methods or reporting units. Data were then grouped into units thought to represent plausible independent populations based on watershed structure. Trends were then estimated for putative populations by estimating the slope (and associated 95% confidence intervals) for the aggregated data. Analysis was restricted to 1) sites where a minimum of 6 years of data were available, and 2) putative populations where more than 65% of all observations were non-zero values.

Nine geographic areas (putative populations) were represented in the aggregated data including Pudding Creek, Noyo River, Caspar Creek, Big River, Little River, Big Salmon Creek, Lagunitas Creek, Redwood Creek, and coastal streams south of San Francisco Bay, including Waddell, Scott, and Gazos creeks. Spatially, these sites cover much of the CCC ESU; however, several key watersheds are not represented, including the Ten Mile, Navarro, Garcia, Gualala,

and Russian Rivers. Although considerable sampling has been done in the Ten Mile River basin, the high proportion of zero values precluded analysis of these data.

**Results—**Overall, analysis of juvenile data provided little evidence of either positive or negative trends for the putative populations examined. Estimated slopes were negative for six populations and positive for three; however, none of the estimated slopes differed significantly from zero (Table C.2.3.5).

Table C.2.3.5. Trend slopes and confidence intervals for nine putative coho populations in the CCC ESU.

| | | | 95% confidence interval | |
|---|---|---|---|---|
| **Watershed** | **No. Sites** | **Aggregate Slope** | **Lower bound** | **Upper bound** |
| Pudding Creek | 1 | -0.019 | -0.103 | 0.065 |
| Noyo River | 8 | -0.091 | -0.195 | 0.013 |
| Caspar Creek | 2 | -0.039 | -0.109 | 0.030 |
| Little River | 2 | -0.044 | -0.118 | 0.029 |
| Big River | 2 | 0.146 | -0.001 | 0.293 |
| Big Salmon Creek | 5 | -0.005 | -0.110 | 0.100 |
| Lagunitas Creek | 3 | 0.095 | -0.123 | 0.312 |
| Redwood Creek | 1 | 0.091 | -0.345 | 0.527 |
| Waddell/Scott/Gazos creeks | 3 | -0.111 | -0.239 | 0.018 |

## C.2.3.3 New Comments

Homer T. McCrary, vice president of Big Creek Lumber, submitted 375 pages comprised primarily of excerpts from historical documents related to operation of hatcheries in Santa Cruz County from the early 1900s to 1990. The expressed intent of this compilation was "to assist the efforts of resource professionals, scientists, regulators, fisheries restoration advocates and all interested parties in establishing a more complete historical perspective on salmonid populations." Quantitative information regarding hatchery and stocking histories is discussed in the Harvest Impact section.

## C.2.3.4 New Hatchery Information

The BRT (Weitkamp et al. 1995) identified four production facilities that had recently produced coho salmon for release in the CCC ESU: the Noyo Egg Collecting Station (reared at Mad River Hatchery) and Don Clausen (Warm Springs) hatchery, both operated by CDFG; Big Creek Hatchery (Kingfisher Flat Hatchery), operated by the Monterey Bay Salmon and Trout Program; and the Silver-King ocean ranching operation. The latter facility closed in the late 1980s.

**Noyo Egg Collecting Station—**The Noyo Egg Collecting Station (ECS), located on the South Fork Noyo River approximately 17 km inland of Fort Bragg, began operating in 1961 and has collected coho salmon in all but a few years since that time. Fish have historically been reared at

the Mad River Hatchery, Don Clausen (Warm Springs) Hatchery, and the Silverado Fish Transfer Station. There are no records of broodstock from other locations being propagated with Noyo fish for release back into the Noyo system, but a few out-of-ESU transfers directly into the Noyo system have been recorded, including Alsea and Klaskanine, OR stocks (SSHAG 2003).

Average annual release of coho salmon yearlings was 108,000 from 1987-1991 (Weitkamp et al. 1995), declined to about 52,000 between 1992 and 1996, and then increased again to about 72,000 fish between 1997 and 2002, inclusive of 2 years where no yearlings were released (Table C.2.3.6). Releases have been made exclusively to the ECS or elsewhere in the South Fork Noyo drainage in the past decade. Between 1991 and 2001, adult returns averaged 572 individuals, though these represent incomplete counts in most years, as counting typically ceased after broodstock needs were met (Grass 2002). On average, 91 females were spawned annually during this 11-year period (Grass 1992-2002).

There are no basin-wide estimates of natural and artificial production for the Noyo Basin as a whole; however, marking of coho salmon juveniles released from the Noyo ECS on the South Fork began in 1997, and returns have been monitored since the 1998-1999 spawning season. In the 1998, 1999, and 2000 broodyears, marked hatchery fish constituted 85%, 70%, and 80%, respectively, of returning adults captured at the ECS.

The BRT (NMFS 1996a) concluded that, although exotic stocks have occasionally been introduced into the Noyo system, the regular incorporation of local natural fish into the hatchery population made the likelihood that this population differs substantially from naturally spawning fish in the ESU is low and, therefore, included them in the ESU. Since CCC coho salmon were listed, no significant changes in hatchery practices have occurred. The Noyo ECS operation has been classified as a Category 1 hatchery (SSHAG 2003).

**Don Clausen (Warm Springs) Hatchery**—The Don Clausen Hatchery (a.k.a. Warm Springs stock), located on Dry Creek in the Russian River system 72 km upstream of the mouth, began operating in 1980. Initial broodstock used were from the Noyo River system, and Noyo fish were planted heavily from 1981 to 1996.

Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 57,000 in the years between 1992 and 1996, and Noyo River broodstock continued to constitute about 30% of the releases during the latter period. Production of coho salmon at the facility ceased entirely after 1996 (Table C.2.3.6). Adult returns averaged 245 fish between 1991 and 1996, but following the cessation of releases, no more than four coho salmon have been trapped at the hatchery in any subsequent year.

Because the Warm Spring population was originally derived from Noyo River stock and continued to receive transfers from the Noyo system throughout its operation, the BRT concluded that the hatchery population was not a part of the ESU.

Beginning in 2001, however, a captive broodstock program was initiated at the Don Clausen facility. A total of 337 juveniles were electro-fished from Green Valley and Mark West Springs creeks, two Russian River tributaries that still appear to support coho salmon, as well as

Olema Creek, a tributary to Lagunitas Creek. Specific mating protocols for these fish have not yet been determined. The captive broodstock program proposes to eventually release 50,000 fingerlings and 50,000 yearlings into five Russian River tributaries. Under the captive broodstock program, the Don Clausen Hatchery has been classified as a Category 1 hatchery (SSHAG 2003).

**Kingfisher Flat (Big Creek) Hatchery—**The Monterey Bay Salmon and Trout Program (MBSTP) has operated Kingfisher Flat Hatchery, located on Big Creek, a tributary to Scott Creek, since 1976. The facility is near the site of the former Big Creek Hatchery, which was operated from 1927 to 1942, when a flood destroyed the facility. An additional facility in Santa Cruz County, the Brookdale Hatchery on the San Lorenzo River, operated from 1905 to 1953. Both the Big Creek and Brookdale hatcheries were supplied with eggs taken at an egg-collection facility located on Scott Creek; additional eggs were provided from other hatcheries around the state. Production of coho salmon at both hatcheries was sporadic. Releases of Sisson (Mt. Shasta) coho salmon were made in Scott Creek and other Santa Cruz County streams in 1913, 1915, and 1917. In subsequent years, releases from both facilities back into Scott Creek in included both Scott Creek fish (1929, 1930, 1934, and 1936-1939), as well as fish from Ft. Seward, Mendocino County (1932), and Prairie Creek, Humboldt County (1933, 1935, and 1939). Throughout these years, only fry were released (generally during July through

Table C.2.3.6. Average annual releases of coho salmon juveniles (fry and smolts) from hatcheries in the CCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002.

| Hatchery | SSHAG Cat. | Annual Average Releases 1987-1991 | 1992-1996 | 1997-2002 |
|---|---|---|---|---|
| Monterey Bay Salmon and Trout | 1 | 25,764[a] | 8,645[b] | 3,622[b] |
| Silver-King | | 95,074[c] | 0[d] | 0[d] |
| Noyo Egg Collecting Station | 1 | 107,918[a] | 52,012[e] | 72,363[e] |
| Don Clausen (Warm Springs) Hatchery | 1 | 123,157[a] | 56,891[f] | 0[f] |
| Total | | 351,913 | 108,903 | 72,363 |

[a] Source: Weitkamp et al. 1995.
[b] No coho released in 1991, 1994, 1997 and 2000; all releases are smolts except for 10,095 fry released in 1996; smolts from San Lorenzo River, Noyo River, and Prairie Creek reared at Big Creek and released into San Lorenzo River are excluded from totals. Sources: MBSTP 1992-1996; Anderson 1996; Jerry Ayers, CDFG, unpublished data.
[c] Average from 4 years of data (1984-1988). Source: Weitkamp et al. 1995.
[d] Ceased operating in the 1980s.
[e] No yearling coho were released in 1995, 2000, or 2001. Sources: Grass 1992-2002.
[f] Releases included both Warm Springs Hatchery and Noyo River ECS fish.. Warm Springs Hatchery ceased releasing coho salmon in 1996. Sources: Cartwright 1994; Williams 1993; Quinones 1994-1997; CDFG Hatchery Staff 2000.

September), and numbers of fish were relatively small. In the 10 years between 1929 and 1939, during which coho salmon were planted in Scott Creek, the total fry release averaged about 34,000 fish. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Since 1976, when MBSTP began operating the Kingfisher Flat Hatchery, only local broodstock has been released back into Scott Creek; some Noyo, Prairie Creek, and San Lorenzo

coho salmon were reared at the hatchery in the early 1990s, but were released into the San Lorenzo River rather than Scott Creek. Mating protocols at the hatchery follow a priority scheme in which wild x wild broodstock are used in years of relatively high abundance, wild x hatchery crosses are done when wild fish are less available, and hatchery x hatchery crosses are made when wild fish are unavailable (D. Streig, MBSTP, pers. comm.). Under the current management plan, up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs observed must be allowed to spawn undisturbed in their natural habitat, and then only one in four females may be taken to spawn. In recent years, few or no fish have been taken, due to low abundance; however, in 2001, 123 coho were observed and 26 "wild" females were taken for spawning. Of the 123 coho observed, 40% were marked hatchery fish. There are no other data available to assess the relative contribution of hatchery versus naturally produced coho salmon.

In its 1996 coho status review update, the BRT concluded that the Kingfisher Flat (Scott Creek) hatchery population should be considered part of the ESU and was essential for ESU recovery (NMFS 1996a). This was based on the fact that there was regular incorporation of local broodstock into the hatchery population in the years that coho were produced between 1905 and 1943, and there have been no out-of-basin or out-of-ESU transfers since the hatchery was restarted in 1976. The MBSTP operation has been classified as a Category 1 hatchery (SSHAG 2003). For other SSHAG categorizations of hatchery stocks, see Appendix C.5.1.

A captive broodstock program for Scott Creek will be initiated at the NMFS Santa Cruz Laboratory in 2003.

## Summary

Artificial propagation of coho salmon within the CCC ESU has been reduced since this ESU was listed in 1996 (Table C.2.3.6). The Don Clausen Hatchery has ceased production of coho salmon, and releases from the Noyo ECS operation declined over the past 6 years, in part because coho were not produced during 2 of those 6 years. The Monterey Bay Salmon and Trout Program has produced few coho salmon for release in the last 6 years due to low adult returns to Scott Creek. Genetic risks associated with out-of-basin transfers appear minimal. However, potential genetic modification in hatchery stocks resulting from domestication selection or low effective population size remains a concern.

## Harvest impacts

Harvest of CCC-origin coho salmon historically occurred in coho- and chinook-directed commercial and recreational fisheries off the coast of California. Coho landing information for various ports in California are available dating back to the 1950s for commercial harvest and the early 1960s for recreational harvest; however, there are no historical estimates of either harvest or exploitation rates specific to CCC coho salmon. Likewise, there is no direct information available about the ocean distribution of coho salmon; however, it is likely that most

CCC-origin coho salmon remain in waters off of California and southern Oregon.[6] Thus, harvest management within this region is most relevant for evaluating harvest impacts.

Through the mid-1980s, the season for directed commercial harvest of coho salmon typically lasted three to almost five months throughout California. In the late 1980s and early 1990s, the commercial salmon seasons throughout California were generally shorter, particular in the region south of Pt. Delgada. By 1992, the commercial coho salmon season was closed completely from the Oregon border south to Horse Mountain, California, and open only 7 days from Pt. Arena to San Pedro. Retention of coho salmon by commercial fishers south of Cape Falcon, Oregon, including all of California, has been prohibited since 1993 (PFMC 2002b). Likewise, retention of coho salmon in recreational fisheries was prohibited in 1994 from Cape Falcon, Oregon, south to Horse Mountain, California. This prohibition was extended to include all California waters in 1996 (PFMC 2003). Non-retention regulations in both commercial and recreational fisheries remain in place throughout coastal California and southern Oregon, but selective fishing for marked hatchery coho salmon has been allowed north of Humbug Mountain, OR since 1999, and some incidental mortality of CCC coho salmon may occur in this fishery. Additionally, coho salmon are also incidentally caught or hooked in chinook fisheries off of California.

Although no estimates of incidental mortality associated with chinook fisheries are available (PFMC 2003), non-retention regulations have undoubtedly resulted in a substantial reduction in harvest-related mortality since 1993. The PFMC (2003) estimates that statewide commercial harvest of coho salmon averaged about 163,000 fish between 1952 and 1991; since 1992 there have been no known landings of coho salmon. Ocean recreational harvest of coho salmon averaged about 34,000 fish from 1962 to 1993. Total estimated incidental and illegal harvest of coho salmon has not exceeded 1000 fish in any year since non-retention regulations were put in place.

There is no legal inside harvest of coho salmon within the CCC ESU; any fishery mortality results from incidental catch-and-release hooking mortality in other fisheries. There are no estimates of inside harvest or mortality of coho salmon in the CCC ESU (PFMC 2003); however, CDFG (2003) considers the potential for significant incidental mortality (and poaching) to be low because of the minimal overlap between the coho migration season and the steelhead season (CDFG 2003).

## C.2.3.5 Comparison with Previous Data

New data for the CCC coho salmon ESU includes expansion of presence-absence analyses, an analysis of juvenile abundance in 13 river basins, smolt counts from two streams in the central portion of the ESU, and one adult time series for a population with mixed wild and hatchery fish. The presence-absence analysis suggests possible continued decline of coho salmon between the late 1980s and the late 1990s, a pattern that is mirrored in the limited smolt and adult counts. Juvenile time series suggest no obvious recent change in status, but most

[6] Rogue/Klamath hatchery stocks, which serve as fishery surrogate stocks for SONCC coho salmon are generally distributed south of Humbug Mountain, Oregon. It is likely that CCC coho salmon exhibit a more southerly ocean distribution.

observations underlying that analysis were made in the period from 1993 to 2002. Coho salmon populations continue to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. A number of coho populations in the southern portion of the range appear either extinct or nearly so, including those in the Gualala, Garcia, and Russian Rivers, as well as smaller coastal streams in San Francisco Bay and South of San Francisco Bay. Although the 2001 broodyear appears to relatively strong, data were not yet available from many of the most at-risk populations within the CCC.

No new information has been provided that suggests additional risks beyond those identified in previous status reviews. Termination of hatchery production at the Don Clausen (Warm Springs) Hatchery and reductions in production at the Noyo and Kingfisher Flat (Big Creek) facilities suggest a decrease in potential risks associated with hatcheries; however, the lack of substantive information regarding the relative contribution of hatchery and naturally produced fish at these facilities adds uncertainty as to the potential risks these operations may pose to the genetic integrity of the Noyo River and Scott Creek stocks. Restrictions on recreational and commercial harvest of coho salmon since 1993-1994 have substantially reduced exploitation rate on CCC coho salmon.

# C.3 COHO SALMON BRT CONCLUSIONS

## Oregon Coast coho salmon ESU

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 and 2002 exceeded the number observed for any year in the past several decades, and pre-harvest run size rivaled some of the high values seen in the 1970s. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by three years of low spawner escapements—the result of three consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These three years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for Oregon Coast coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are generally positive, the long-term trends in productivity in this ESU are still strongly negative.

The BRT votes reflected ongoing concerns for the long-term health of this ESU: a majority (56%) of the FEMAT votes were cast in the "likely to become endangered" category, with a substantial minority (44%) falling in the "not likely to become endangered" category (Table C.3.1). Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance. As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU (mean score 3.2; Table C.3.2). With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions. With the cushion provided by strong returns in the last 2-3 years, the BRT had much less concern about short-term risks associated with abundance (mean score 1.9).

A minority of the BRT felt that the large number of spawners in the last few years demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

## Southern Oregon/Northern California Coasts coho salmon ESU

A majority (67%) of BRT votes fell into the "likely to become endangered" category, while votes in the "endangered" category outnumbered those in the "not warranted" categories by 2-to-1 (Table C.3.1). The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure (mean score = 3.1) and diversity (mean score = 2.8) were considered moderate by the BRT (Table C.3.2).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue; however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from broodyear 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain; however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems a well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon. The BRT's concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

## Central California coho salmon ESU

A large majority (74%) of the BRT votes fell into the "endangered" category, with the remainder falling into the "likely to become endangered" category (Table C.3.1). The BRT found CCC coho salmon to be at very high risk in three of four risk categories, with mean scores of 4.8, 4.5, and 4.7 for abundance, growth rate/productivity, and spatial structure, respectively (Table C.3.2). Scores for diversity (mean 3.6) indicated BRT members considered CCC coho

salmon to be at moderate or increasing risk with respect to this risk category. Principal concerns of the BRT continue to be low abundance and long-term downward trends in abundance of coho salmon throughout the ESU, as well as extirpation or near extirpation of populations across most of the southern two-thirds of the historical range of the ESU, including several major river basins. Potential loss of genetic diversity associated with range reductions or loss of one or more brood lineages, coupled with historical influence of hatchery fish, were primary risks to diversity identified by the BRT. Improved oceanic conditions coupled with favorable stream flows apparently contributed to a strong year class in broodyear 2001, as evidenced by an increase in detected occupancy of historical streams. However, data were lacking for many river basins in the southern two-thirds of the ESU where populations are considered at greatest risk. Although viewed as a positive sign, the strong year follows more than a decade of relatively poor returns. The lack of current estimates of naturally produced spawners for any populations within the ESU—and hence the need to use primarily presence-absence information to assess risk—continues to concern the BRT.

## Lower Columbia River coho salmon ESU

The status of this ESU was reviewed by the BRT in 2000, so relatively little new information was available. A majority (68%) of the likelihood votes for Lower Columbia River coho salmon fell in the "danger of extinction" category, with the remainder falling in the "likely to become endangered" category (Table C.3.1). As indicated by the risk matrix totals (Table C.3.2), the BRT had major concerns for this ESU in all VSP risk categories (mean scores ranged from 4.2 for spatial structure/connectivity and growth rate/productivity to 4.5 for diversity). The most serious overall concern was the scarcity of naturally produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas.

The paucity of naturally produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

Table C.3.1. Tally of FEMAT vote distribution regarding the status of 4 coho salmon ESUs reviewed by the coho salmon BRT. Each of 13 BRT members allocated 10 points among the three status categories.

| ESU | Danger of Extinction | Likely to Become Endangered | Not Likely to Become Endangered |
|---|---|---|---|
| Oregon Coast | 0 | 73 | 57 |
| S. Oregon / N. California Coasts | 29 | 87 | 14 |
| Central California | 96 | 34 | 0 |
| Lower Columbia River | 88 | 42 | 0 |

Table C.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 4 coho salmon ESUs reviewed. Data presented are means (range).

| ESU | Abundance | Growth Rate/Productivity | Spatial Structure and Connectivity | Diversity |
|---|---|---|---|---|
| Oregon Coast | 1.9 (1-3) | 3.2 (2-4) | 2.3 (1-3) | 2.5 (2-3) |
| S. Oregon / N. California Coasts | 3.8 (2-5) | 3.5 (2-5) | 3.1 (2-4) | 2.8 (2-4) |
| Central California | 4.8 (4-5) | 4.5 (4-5) | 4.7 (4-5) | 3.6 (2-5) |
| Lower Columbia River | 4.4 (4-5) | 4.2 (3-5) | 4.2 (2-5) | 4.5 (4-5) |

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